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FHWA HIGHWAY CONSTRUCTION NOISE HANDBOOK

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U.S. Department of Transportation
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Prepared by:
U.S. Department of Transportation
Research and Innovative Technology Administration
John A. Volpe National Transportation Systems Center
Environmental Measurement and Modeling Division, Acoustics Facility
Cambridge, MA 02142

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3.0 EFFECTS OF CONSTRUCTION NOISE

3.1 Introduction

Construction noise in the community may not pose a health risk or damage peoples' sense of hearing, but it can adversely affect peoples' quality of life. To some degree, construction noise can be a contributing factor to the degradation of someone's health in that it can cause people to be irritated and stressed and can interrupt their ability to sleep – all of which may lead to higher blood pressure, anxiety, and feelings of animosity toward the people or agencies responsible for producing the noise.

In fact, several of the traditional definitions of "noise" (i.e. unwanted or undesirable sound) can be associated with construction noise. Construction noise can be perceived or considered to:

- be too loud;
- be impulsive;
- be uncontrollable;
- contain annoying pure tones;
- occur unexpectedly;
- occur at undesirable times of day; and/or
- interrupt people's activities.

Construction noise has the potential to disturb people at home in their residences, in office buildings or retail businesses, in public institutional buildings, at locations of religious services, while attending sporting events, or when on vacation.

Figure 3.1 Construction in residential area
(Photo #924)

Figure 3.2 Construction in business district
(Photo #714)

Figure 3.3 Construction in vicinity of sporting event venue
(Photo #718)

Figure 3.4 Construction in paradise
(Photo #1033)

While construction noise can be unwelcome during nighttime periods in residential areas when people are trying to sleep, it can be equally unwelcome during the daytime in commercial areas if it interferes with peoples' ability to conduct business. In short, construction noise has the potential to disturb people 24 hours a day, 7 days a week. If not properly addressed, specific public concerns related to a project could result in actions affecting the progress and/or cost of a project.

There is nothing particularly unique about construction noise – it's a fluctuation in air pressure oscillating above and below atmospheric pressure that is produced by construction equipment or activities with sufficient magnitude (loudness) and within a certain frequency range (audible spectrum) such that human beings can hear it – just like any other noise. Being a physical parameter, it can be measured, quantified, modeled, predicted, and in certain instances, abated to some degree.

Noise from construction-related activities can also affect non-human species such as aquatic life and land and airborne animals in a variety of ways. The non-human category includes domestic, farm-based, and creatures living in the wild. In assessing the effects of noise on non-humans, it is essential that noise analysts closely coordinate with qualified biologists in the assessment and mitigation of noise impacts.

Issues related to vibration may also be raised during project development. This is particularly true when blasting operations occur. There are no FHWA requirements directed specifically to traffic-induced or construction-related vibration. Most studies that State DOTs have done to assess the impact of operational traffic-induced vibrations have shown that both measured and predicted vibration levels are less than any known criteria for structural damage to buildings, although levels may be such as to cause various degrees of annoyance. Analysis of construction-related vibration effects is beyond the scope of this Handbook.

The intent of this Handbook is not to provide detailed discussion of the above-listed effects, but rather to summarize them and refer the reader to more detailed information regarding specific effects of construction-related noise.

3.2 Types of Effects

3.2.1 Physical Effects

Physical effects related to humans are probably most applicable to the operators of construction equipment as opposed to people residing adjacent to construction projects. An exception to this would be unique situations such as scuba diving or swimming activities occurring in the vicinity of a water-based pile driving or blasting operation. The potential for hearing loss or physical damage to the human hearing mechanism is protected by Occupational Safety and Health Administration (OSHA) criteria, and as such, is not discussed herein. While resulting in the potential to annoy or disturb humans, construction noise is typically not a danger to people's hearing.

Knowledge related to the physical effects of construction noise on non-human species such as land-based animals, birds, and owls is limited. It is recognized that aquatic mammals and fish can be physically damaged by water-born sound and vibration waves caused by construction activities such as underwater blasting and pile driving. In lieu of detailed discussions within this Handbook of the variety of specialized studies related to the physical effects of construction noise on such species, references to such studies are provided in a list at the end of this chapter.

3.2.2 Speech Interference

Loud noises from construction activities can create situations where people cannot effectively communicate, as documented in Tables 3.1 and 3.2. While such situations may be merely an annoyance or inconvenience in certain situations, they could be construed as a safety issue if such noises prevent people from hearing important local noises such as approaching traffic, emergency warning devices, alerts from other people, etc.

3.2.3 Activity Interference

Noise from construction activities can affect humans, land-based animals, aquatic wildlife, and airborne wildlife in a variety of ways. Humans are most affected in terms of sleep deprivation and the carrying on of normal daily activities such as watching television, listening to the radio, recreational activities, and activities requiring concentration, such as reading. Special activities such as those associated with

churches, schools, and libraries can also be negatively affected by construction noise. Water-based activities such as scuba diving, swimming, and boating can also be affected.

3.2.4 Annoyance

While non-humans are most likely annoyed by construction noise, there is little known about the related effects. However, the annoyance of noise on humans has been studied for some time and is documented in a 1974 EPA report commonly referred to as the "Levels Document"[ref033]. It is complementary to the 1979 EPA document, "Protective Noise Levels"[ref052].

3.2.5 Examples of Data from Previous Studies (Effects on Humans)

A variety of studies have attempted to quantify the effects of noise on humans. An example is provided in the following table contained in the "Levels Document" referred to above. Note that all noise levels referred to in the "Levels Document" are A-weighted.

Table 3.1 Summary of Human Effects in Terms of Speech Communication, Community Reactions, Annoyance, and Attitude toward Area Associated with an Outdoor Day/Night Sound Level of 55 dB re 20 Micropascals.

Type of Effect	Magnitude of Effect
Speech - Indoors	100% sentence intelligibility (average) with a 5 dB margin of safety
Speech - Outdoors	100% sentence intelligibility (average) at 0.35 meters
	99% sentence intelligibility (average) at 1.0 meters
	95% sentence intelligibility (average) at 3.5 meters
Average Community Reaction	None evident; 7 dB below level of significant "complaints and threats of legal action" and at least 16 dB below "vigorous action" (attitudes and other non-level related factors may affect this result)
Complaints	1% dependent on attitude and other non-level related factors
Annoyance	1% dependent on attitude and other non-level related factors
Attitude Toward Area	Noise essentially the least important of various factors

Table 3.2. Steady A-weighted Sound Levels that Allow Communication with 95 Percent Sentence Intelligibility over Various Distances Outdoors for Different Voice Levels.

Communication Distance (meters)	0.5	1	2	3	4	5
Normal Voice (dB)	72	66	60	56	54	52
Raised Voice (dB)	78	72	66	62	60	58

3.2.6 Effects on Non-Humans

The effects of construction-related noise on non-humans are less understood and probably most related to mating, nesting, migration, and feeding activities. While data on such effects is limited as compared with information on humans, some research is available[ref031 and ref032].

For a more detailed discussion of the general effects of noise on wildlife and other non-human species, the reader is directed to references dealing with the following:

- Effects on wildlife and other animals: ref031 and ref 032;
- Effects on marine mammals: ref 102;
- Effects on fish: ref030, ref036, ref046, ref054, ref060, and ref061; and
- Effects on owls: research underway as of the publication date of this Handbook by Washington State DOT (WSDOT); when available, any published reports will be available through the WSDOT webpage (see Table 10.1).

In determining noise impacts and possible mitigation measures for construction projects involving non-human species, noise analysts should closely coordinate with qualified biologists.

4.0 CONSTRUCTION NOISE CRITERIA AND DESCRIPTORS

4.1 Criteria

Construction noise levels may be evaluated in terms of human response and considered in the assessment of effects on wildlife and other non-human species. Noise levels and criteria are expressed in English, metric, or both conventions, depending upon the geographic area or the policies of the controlling agency. Typically, the English convention is used mostly in the United States, with the metric convention used in Canada and other countries.

While the issue of construction noise must be addressed as part of the planning of any transportation project, there are no standardized criteria on the federal level for assessing construction noise impacts related to transportation projects. Where project-specific construction noise criteria have been developed by individual agencies or municipalities, they typically consider the following factors which form the fundamentals for defining construction noise impact:

- Difference between existing noise levels prior to construction startup and expected noise levels during construction: This takes into account specific construction operations and/or individual pieces of equipment.

- Absolute level of expected construction noise: This may constitute the combined levels of all equipment and operations at a given time or be specifically related to the absolute noise level of a specific operation and/or piece of equipment.

- Adjacent land uses: Consideration of this factor provides an indicator of the degree of sensitivity that may be expected and will likely have a major effect on the operational time restraints and the noise level increases tolerated. For example, residential areas may typically have a restriction on night operations and possibly a noise level restriction during the day. Industrial areas may have no restrictions at all, and offices may or may not have a restriction on the noise levels during the day, with possibly no restriction for night operations. Examples of absolute and relative construction noise level criteria are provided in Table 7.1.

- Duration of construction/operation: The duration of high noise levels may play a significant role in how a noise impact is perceived and/or mitigated. If the levels are of a brief nature, possibly only occurring once or twice during the project, the perceived impact could be quite different than that associated with a constant noise source. Similarly, any related noise mitigation techniques employed could be substantially different in terms of type and/or duration of application.

4.1.1 History of Construction Noise Criteria

4.1.1.1 United States

While noise impact and abatement criteria have been established for the operation of transportation facilities in the United States, standardized criteria have not yet been established related to noise associated with the construction of such facilities. However, since the publication of the original 1977 Report[ref001], additional guidance has been disseminated (through agencies such as FHWA and FTA) and

analysis tools developed to better address construction noise. For example, the FTA Transit Noise and Vibration Impact Assessment document[ref014] presents guidelines that "can be considered reasonable criteria for assessment" of construction noise impacts. In addition, a number of agencies, municipalities, and other entities have developed procedures for addressing construction noise impacts and implementing related noise mitigation for their areas of jurisdiction or on a project-specific basis.

In some instances, local entities may have developed noise ordinances that contain restrictions associated with construction noise levels. Noise practitioners and others involved in the project development process are encouraged to become familiar with such ordinances and their relationship to other State and/or municipal ordinances. In certain instances, the State jurisdiction may supersede any local noise ordinances.

Figure 4.1 Local noise ordinance
(Photo #314)

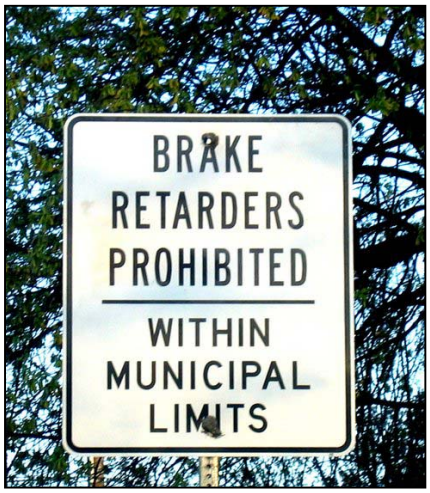

Figure 4.2 Local noise restrictions
(Photo #1206)

Noise restrictions may also be imposed by local and/or State authorities to deal with specific activities or operations. An example is the growing practice of restricting the use of engine compression brakes on heavy trucks in residential areas.

Noise restrictions may also be applied within the workplace associated with employee/worker exposure to noise levels over varying durations. These criteria have been established by OSHA. However, such criteria are typically not relevant or applicable to the transportation-related project construction noise levels experienced by people residing or working in areas adjacent to such projects. As such, they are not discussed within this Handbook.

Construction noise criteria within the United States vary considerably in terms of both scope and specificity and can be broadly categorized as follows, in order of complexity:

- No criteria specified;
- Qualitative criteria, e.g. "Noise levels shall not cause a disturbance";

- Relative criteria, e.g. "Noise levels shall not exceed existing (or ambient, or background) noise levels by more than x dB";
- Absolute criteria, e.g. "Maximum noise levels shall not exceed xx dB";
- Criteria containing a combination absolute and relative noise level limits; and
- Combinations of the above criteria elements with additional restrictions placed on time periods and types of land uses or activities.

An example of more complex criteria is that associated with the Central Artery/Tunnel Project in Boston, MA. Data related to these criteria are discussed in Reference 023 and illustrated in Table 7.1 of this Handbook. This project established criteria that include both L_{10} and L_{max} absolute noise level limits for defined noise sensitive locations (residences, institutions, hotels, etc.) for daytime, evening, and nighttime periods. In addition, the criteria established maximum noise level increases relative to established baseline noise levels. Relative and absolute noise level limits were also established for commercial and industrial areas.

From the standpoint of construction noise criteria, the intent of this Handbook is not to address all State and local noise ordinances and/or criteria, but rather, to address the approaches and techniques that may be contained in such criteria. As such, the discussions contained within this Handbook are meant to provide a summary of considerations related to all aspects of construction noise. The reader is encouraged to refer to specific references in Table 10.1 for more detailed information on noise criteria and other factors related to construction noise.

4.1.1.2 Canada

Similar to the United States, no standardized Canadian criteria exist related to transportation project construction noise. Where project-specific analysis techniques have been employed to address and/or mitigate construction-related noise and its impacts, such methods have been similar to those employed in the United States. Examples of such efforts may be found in References 010 and 019.

4.1.1.3 Other International

While an exhaustive survey of international criteria was not conducted, several criteria are discussed here for informational use only. More specifics may be found by accessing the relative links found in the Reference Database in Chapter 10.

- The Official Journal of the European Communities' Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000[ref017] establishes legislation dictating specific noise levels for individual pieces of construction equipment. It also contains specifics related to the measurement locations and equipment operating conditions relative to the testing of individual pieces of equipment.
- The Australian EPA's Environmental Noise Control Manual[ref015] establishes the following criteria which officers may specify related to construction noise:
    - For a construction period of four (4) weeks or less, the maximum L_{10} noise level measured over a period of not less than 15 minutes when the construction site is operating must not exceed the background noise level by more than 20 dBA;

- For a construction period greater than four (4) weeks, the maximum L_{10} noise level measured over a period of not less than 15 minutes when the construction site is operating must not exceed the background noise level by more than 10 dBA;
- Construction limited to 0700 to 1800 time period on Monday through Friday;
- Construction limited on Saturdays to 0700 to 1300 time period if inaudible on residential premises; otherwise, 0800 to 1300;
- No construction work may take place on Sundays or public holidays; and
- All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24-hour operation is necessary.

4.2 Descriptors

While it is not the intent of this Handbook to establish criteria for evaluating construction noise impacts, it is important to stress that reasonable and defensible noise descriptors must be used to describe construction noise levels. The following are important elements related to selecting a workable noise descriptor for use in measuring and analyzing construction noise:

- Suitable for practical measuring methods;
- Accounts for temporal variations in equipment noise levels;
- Accounts for temporal variations in overall site noise level;
- Suitable for prediction modeling;
- Suitable for combining noise levels from various source types; and
- Relative to subjective responses.

The descriptor most commonly chosen for use is the A-weighted equivalent sound level (energy basis), L_{Aeq}. In many cases, the time average period applied to the L_{Aeq} value is one hour (designated L_{Aeq1h}). For certain projects and operations, the time period over which the L_{Aeq} is applied may need to be examined on a case-by-case basis. For several major construction projects in the United States and Canada, the L_{10} (applied generally during daytime periods) and L_{max} (applied for specific equipment and/or nighttime operations) descriptors have been used over varying time periods.

The L_{dn} descriptor has been used to assess annoyance and community reaction to construction noise. L_{dn} is an L_{Aeq}-based descriptor that applies a 10 dBA penalty to nighttime noise levels.

The L_{Aeq}-based and L_{10}-based descriptors satisfy the first four elements listed above. The L_{Aeq} satisfies the fifth element and may also satisfy the sixth element (relative to subjective responses). However, the L_{Aeq}, L_{10}, and L_{max} descriptors may not be suited for determining responses by some aquatic wildlife (where using an un-weighted sound pressure level may be more suitable) or for owls (where use of a different weighting category such as dBO or a descriptor such as SEL may be more suitable to account for effects such as air blasts associated with blasting). More detailed information related to these specific conditions might be found in documents listed in Section 3.2.6 of this document.

9.0 CONSTRUCTION EQUIPMENT NOISE LEVELS AND RANGES

9.1 Equipment Type Inventory and Related Emission Levels

Noise levels generated by individual pieces of construction equipment and specific construction operations form the basis for the prediction of construction-related noise levels. A variety of information exists related to sound emissions related to such equipment and operations. This data transcends the period beginning in the 1970s thru 2006. This information exists for both stationary and mobile sources and for steady, intermittent, and impulse type generators of noise.

9.1.1 Stationary Equipment

Stationary equipment consists of equipment that generates noise from one general area and includes items such as pumps, generators, compressors, etc. These types of equipment operate at a constant noise level under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as pile drivers, jackhammers, pavement breakers, blasting operations, etc., produce variable and sporadic noise levels and often produce impact-type noises. Impact equipment is equipment that generates impulsive noise, where impulsive noise is defined as noise of short duration (generally less than one second), high intensity, abrupt onset, rapid decay, and often rapidly changing spectral composition. For impact equipment, the noise is produced by the impact of a mass on a surface, typically repeating over time.

9.1.2 Mobile Equipment

Mobile equipment such as dozers, scrapers, graders, etc., may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. Other equipment such as compressors, although generally considered to be stationary when operating, can be readily relocated to another location for the next operation.

9.2 Sources of Information

Construction-related equipment and operation noise level data may be provided by numerous sources, including suppliers, manufacturers, agencies, organizations, etc. Some information is included in this document, and many web-based links are given for equipment manufacturers.

9.3 Specifics of Construction Equipment and Operation Noise Inventories

Details included in each specific inventory of construction equipment and operation noise emission levels are often variable in terms of how data is represented. Some inventories include ranges of noise levels while others present single numbers for each equipment type. Others provide levels for specific models of each type of construction equipment. Often, different noise descriptors are used, such as L_{Aeq}, L_{max}, L_{10}, sound power level, etc. As such, the array of data does not readily lend itself to being combined into a single table or easily compared. As such, this Handbook attempts to summarize a variety of such inventories and provide links to each, thereby providing the reader with a variety of sources from which to choose the appropriate levels for use in his or her respective analysis.

9.4 Summaries of Referenced Inventories

Included below are examples of several inventories of construction-related noise emission values. These and additional inventories are included on the companion CD-ROM.

9.4.1 RCNM Inventory

Equipment and operation noise levels in this inventory are expressed in terms of L_{max} noise levels and are accompanied by a usage factor value. They have been recently updated and are based on extensive measurements taken in conjunction with the Central Artery/Tunnel (CA/T) Project. Table 9.1 summarizes the equipment noise emissions database used by the CA/T Project. While these values represent the "default" values for use in the RCNM, user-defined equipment and corresponding noise levels can be added.

Table 9.1 RCNM Default Noise Emission Reference Levels and Usage Factors.

Equipment Description	Impact Device?	Acoustical Usage Factor (%)	Spec. 721.560 L_{max} @ 50 feet (dBA, slow)	Actual Measured L_{max} @ 50 feet (dBA, slow) (Samples Averaged)	Number of Actual Data Samples (Count)
All Other Equipment > 5 HP	No	50	85	N/A	0
Auger Drill Rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Bar Bender	No	20	80	N/A	0
Blasting	Yes	N/A	94	N/A	0
Boring Jack Power Unit	No	50	80	83	1
Chain Saw	No	20	85	84	46
Clam Shovel (dropping)	Yes	20	93	87	4
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Concrete Batch Plant	No	15	83	N/A	0
Concrete Mixer Truck	No	40	85	79	40
Concrete Pump Truck	No	20	82	81	30
Concrete Saw	No	20	90	90	55
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Drill Rig Truck	No	20	84	79	22
Drum Mixer	No	50	80	80	1
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19
Generator (<25KVA, VMS Signs)	No	50	70	73	74
Gradall	No	40	85	83	70
Grader	No	40	85	N/A	0
Grapple (on backhoe)	No	40	85	87	1

Equipment Description	Impact Device?	Acoustical Usage Factor (%)	Spec. 721.560 L_{max} @ 50 feet (dBA, slow)	Actual Measured L_{max} @ 50 feet (dBA, slow) (Samples Averaged)	Number of Actual Data Samples (Count)
Horizontal Boring Hydraulic Jack	No	25	80	82	6
Hydra Break Ram	Yes	10	90	N/A	0
Impact Pile Driver	Yes	20	95	101	11
Jackhammer	Yes	20	85	89	133
Man Lift	No	20	85	75	23
Mounted Impact Hammer (hoe ram)	Yes	20	90	90	212
Pavement Scarifier	No	20	85	90	2
Paver	No	50	85	77	9
Pickup Truck	No	40	55	75	1
Pneumatic Tools	No	50	85	85	90
Pumps	No	50	77	81	17
Refrigerator Unit	No	100	82	73	3
Rivit Buster/Chipping Gun	Yes	20	85	79	19
Rock Drill	No	20	85	81	3
Roller	No	20	85	80	16
Sand Blasting (single nozzle)	No	20	85	96	9
Scraper	No	40	85	84	12
Sheers (on backhoe)	No	40	85	96	5
Slurry Plant	No	100	78	78	1
Slurry Trenching Machine	No	50	82	80	75
Soil Mix Drill Rig	No	50	80	N/A	0
Tractor	No	40	84	N/A	0
Vacuum Excavator (Vac-Truck)	No	40	85	85	149
Vacuum Street Sweeper	No	10	80	82	19
Ventilation Fan	No	100	85	79	13
Vibrating Hopper	No	50	85	87	1
Vibratory Concrete Mixer	No	20	80	80	1
Vibratory Pile Driver	No	20	95	101	44
Warning Horn	No	5	85	83	12
Welder/Torch	No	40	73	74	5

For each generic type of equipment listed in Table 9.1, the following information is provided:

- an indication as to whether or not the equipment is an impact device;
- the acoustical usage factor to assume for modeling purposes;
- the specification "Spec" limit for each piece of equipment expressed as an L_{max} level in dBA "slow" at a reference distance of 50 foot from the loudest side of the equipment;
- the measured "Actual" emission level at 50 feet for each piece of equipment based on hundreds of emission measurements performed on CA/T work sites; and
- the number of samples that were averaged together to compute the "Actual" emission level.

A comparison of the "Spec" emission limits against the "Actual" emission levels reveals that the Spec limits were set, in general, to realistically obtainable noise levels based on the equipment used by contractors on the CA/T Project. When measured in the field, some equipment such as pile drivers, sand

blasting, demolition shears, and pumps tended to exceed their applicable emission limit. As such, these noisy devices needed to have some form of noise mitigation in place in order to comply with the Spec emission limits. Other equipment, such as clamshell shovels, concrete mixer trucks, truck-mounted drill rigs, man-lifts, chipping guns, ventilation fans, pavers, dump trucks, and flatbed trucks, easily complied. Therefore, the Spec emission limits for these devices could have been reduced somewhat further. It is recommended that the user review the RCNM User's Guide contained in Appendix A for detailed guidance regarding application of values contained in Table 9.1.

9.4.2 FHWA Special Report Inventories

Appendix A of the 1977 Handbook provides tables of construction equipment noise levels and ranges. The majority of the data were provided by the American Road Builders Association. These data were taken during a 1973 survey in which member contractors were asked to secure readings of noise exposure to operators of various types of equipment. Additionally, the contractors were asked to take readings at 50 feet from the machinery. These 50-foot peak readings are provided in Tables 9.2 through 9.8. Though the data were produced under varying conditions and degrees of expertise, the values are relatively consistent.

Table 9.2 Construction Equipment Noise Levels Based on Limited Data Samples - Cranes.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Northwestern	80D	77	Within 15m 1958 mod
Northwestern	8	84	Within 15m 1940 mod
Northwestern	6	72	Within 15m 1965 mod
American	7260	82	Within 15m 1967 mod
American	599	76	Within 15m 1969 mod
American	5299	70	Within 15m 1972 mod
American	4210	82	Within 15m 1968 mod
Buck Eye	45C	79	Within 15m 1972 mod
Buck Eye	308	74	Within 15m 1968 mod
Buck Eye	30B	73	Within 15m 1965 mod
Buck Eye	30B	70	Within 15m 1959 mod
Link Belt	LS98	76	Within 15m 1956 mod
Manitowoc	4000	94	Within 15m 1956 mod
Grove	RF59	82	Within 15m 1973 mod
Koehr	605	76	Within 15m 1967 mod
Koehr	435	86	Within 15m 1969 mod
Koehr	405	84	Within 15m 1969 mod

Table 9.3 Construction Equipment Noise Levels Based on Limited Data Samples - Backhoes.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Link Belt	4000	92	Within 15m 1971 mod
John Deere	609A	85	Within 15m 1971 mod
Case	680C	74	Within 15m 1973 mod
Drott	40 yr.	82	Within 15m 1971 mod
Koehr	1066	81 & 84	Within 15m 2 tested

Table 9.4 Construction Equipment Noise Levels Based on Limited Data Samples - Front Loaders.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	980	84	Within 15m 1972 mod
Caterpillar	977K	79	Within 15m 1969 mod
Caterpillar	977	87	Within 15m 1971 mod
Caterpillar	977	94	Within 15m 1967 mod
Caterpillar	966C	84	Within 15m 1973 mod
Caterpillar	966C	85	Within 15m 1972 mod
Caterpillar	966	81	Within 15m 1972 mod
Caterpillar	966	77	Within 15m 1972 mod
Caterpillar	966	85	Within 15m 1966 mod
Caterpillar	955L	90	Within 15m ;1973 mod
Caterpillar	955K	79	Within 15m 1969 mod
Caterpillar	955H	94	Within 15m 1963 mod
Caterpillar	950	78 & 80	Within 15m 1972 mod
Caterpillar	950	75	Within 15m 1968 mod
Caterpillar	950	88	Within 15m 1967 mod
Caterpillar	950	86	Within 15m 1965 mod
Caterpillar	944A	80	Within 15m 1965 mod
Caterpillar	850	82	Within 15m 1968 mod
Michigan	75B	90	Within 15m 1969 mod
Michigan	475A	96	Within 15m 1967 mod
Michigan	275	85	Within 15m 1971 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Michigan	125	87	Within 15m 1967 mod
Hough	65	82	Within 15m 1971 mod
Hough	60	91	Within 15m 1961 mod
Hough	400B	94	Within 15m 1961 mod
Hough	H90	86	Within 15m 1961 mod
Trojan	3000	85	Within 15m 1956 mod
Trojan	RT	82	Within 15m 1965 mod
Payloader	H50	85	Within 15m 1963 mod

Table 9.5 Construction Equipment Noise Levels Based on Limited Data Samples - Dozers.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	D5	83	Within 15m 1967 mod
Caterpillar	D6	85	Within 15m 1967 mod
Caterpillar	D6	86	Within 15m 1964 mod
Caterpillar	D6	81	Within 15m 1967 mod
Caterpillar	D6B	83	Within 15m 1967 mod
Caterpillar	D6C	82	Within 15m 1962 mod
Caterpillar	D7	85	Within 15m 1956 mod
Caterpillar	D7	86	Within 15m 1969 mod
Caterpillar	D7	84	Within 15m 1969 mod
Caterpillar	D7	78	Within 15m 1970 mod
Caterpillar	D7	78	Within 15m 1972 mod
Caterpillar	D7E	86	Within 15m 1965 mod
Caterpillar	D7E	78	Within 15m 1970 mod
Caterpillar	D7E	84	Within 15m 1973 mod
Caterpillar	D7F	80	Within 15m 1972 mod
Caterpillar	D8	92	Within 15m 1954 mod
Caterpillar	D8	95	Within 15m 1968 mod
Caterpillar	D8	86	Within 15m 1972 mod
Caterpillar	D8H	88	Within 15m 1966 mod
Caterpillar	D8H	82	Within 15m 1972 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	D9	85	Within 15m 1972 mod
Caterpillar	D9	94	Within 15m 1972 mod
Caterpillar	D9	90	Within 15m 1963 mod
Caterpillar	D9	87	Within 15m 1965 mod
Caterpillar	D9	90	Within 15m 1965 mod
Caterpillar	D9	88	Within 15m 1968 mod
Caterpillar	D9	92	Within 15m 1972 mod
Caterpillar	D9G	85	Within 15m 1965 mod
Allis Chambers	HD41	93	Within 15m 1970 mod
International	TD15	79	Within 15m 1970 mod
International	TD20	87	Within 15m 1970 mod
International	TD25	90	Within 15m 1972 mod
International	TD8	83	Within 15m 1970 mod
Case	1150	82	Within 15m 1972 mod
John Deer	350B	77	Within 15m 1971 mod
John Deer	450B	65	Within 15m 1972 mod
Terex	8230	70	Within 15m 1972 mod
Terex	8240	93	Within 15m 1969 mod
Michigan	280	85	Within 15m 1961 mod
Michigan	280	90	Within 15m 1962 mod
Caterpillar	824	90	Within 15m 1968 mod

Table 9.6 Construction Equipment Noise Levels Based on Limited Data Samples - Graders.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	16	91	Within 15m 1969 mod
Caterpillar	16	86	Within 15m 1968 mod
Caterpillar	140	83	Within 15m 1970 mod
Caterpillar	14E	84	Within 15m 1972 mod
Caterpillar	14E	85	Within 15m 1971 mod
Caterpillar	14C	85	Within 15m 1971 mod
Caterpillar	14B	84	Within 15m 1967 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	12F	82	Within 15m 1961-72 mod
Caterpillar	12F	72-92	Within 15m 1961-72 mod
Caterpillar	12E	81.3	Within 15m 1959-67 mod
Caterpillar	12E	80-83	Within 15m 1959-67 mod
Caterpillar	12	84.7	Within 15m 1960-67 mod
Caterpillar	12	82-88	Within 15m 1960-67 mod
Gallon	T500	84	Within 15m 1964 mod
Allis Chambers		87	Within 15m 1964 mod

Table 9.7 Construction Equipment Noise Levels Based on Limited Data Samples - Scrapers.

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Caterpillar	660	92	Within 15m
Caterpillar	641B	85	Within 15m 1972 mod
Caterpillar	641B	86	Within 15m 1972 mod
Caterpillar	641	80 & 84	Within 15m 1972 mod
Caterpillar	641	83 & 89	Within 15m 1965 mod
Caterpillar	637	87	Within 15m 1971 mod
Caterpillar	633	87	Within 15m 1972 mod
Caterpillar	631C	89	Within 15m 1973 mod
Caterpillar	631C	83	Within 15m 1972 mod
Caterpillar	631B	94	Within 15m 1969 mod
Caterpillar	631B	84-87	Within 15m 1968 mod
Caterpillar		85 avg.	Within 15m 1968 mod
Caterpillar	621	90	Within 15m 1970 mod
Caterpillar	621	86	Within 15m 1967 mod
Caterpillar	613	76	Within 15m 1972 mod
Terex	TS24	87	Within 15m 1972 mod
Terex	TS24	84-91	
Terex	TS24	82	Within 15m 1971 mod
Terex	TS24	81-83	Within 15m 1971 mod
Terex	TS24	94	Within 15m 1966 mod

Manufacturer	Type or Model	Peak Noise Level (dBA)	Remarks
Terex	TS24	92-98	Within 15m 1966 mod
Terex	TS24	94.7	Within 15m 1963 mod
Terex	TS24	94-95	Within 15m 1963 mod
Terex	TS14	82	Within 15m 1969 mod
Terex	S35E	84	Within 15m 1971 mod

Table 9.8 Noise Levels of Standard Compressors.

Manufacturer	Model	Silenced or Standard	Type Eng.	Type Comp.	Test Avg. Cond. (cfm.psi)	Avg. Cond. Noise Lev. (cfm.psi) (dBA) at 7m*
Atlas	ST-48	Standard	Diesel	Reciprocal	160,100	83.6
Atlas	ST-95	Standard	Diesel	Reciprocal	330,105	80.2
Atlas	VSS-170Dd	Silenced	Diesel	Reciprocal	170,850	70.2
Atlas	VT-85M	Standard	Gas	Reciprocal	85,100	81.4
Atlas	VS-85Dd	Silenced	Gas	Reciprocal	85,100	75.5
Atlas	VSS-125Dd	Silenced	Diesel	Reciprocal	125,100	70.1
Atlas	STS-35Dd	Silenced	Diesel	Reciprocal	125,100	73.5
Atlas	VSS-170Dd	Silenced	Diesel	Reciprocal	170,100	
Gardner-Denver	SPWDA/2	Silenced	Diesel	Rotary-Screw	1200,000	73.3
Gardner-Denver	SPQDA/2	Silenced	Diesel	Rotary-Screw	750,000	78.2
Gardner-Denver	SPHGC	Silenced	Gas	Rotary-Screw	185,000	77.1
Ingersoll-Rand	DXL 1200	Standard	Diesel	Rotary-Screw	1200,125	92.6
Ingersoll-Rand	DXL 1200 (doors open)	Standard	Diesel	Rotary-Screw	1200,125	
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	76.0
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	75.1
Ingersoll-Rand	DXLCU1050	Standard	Diesel	Rotary-Screw	1050,125	90.2
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	75.3
Ingersoll-Rand	DXL 900S	Silenced	Diesel	Rotary-Screw	900,125	75.0
Ingersoll-Rand	DXL 900	Standard	Diesel	Rotary-Screw	900,125	89.9
Ingersoll-Rand	DXL 750	Standard	Diesel	Rotary-Screw	750,125	87.7
Jaeger	A	Standard	Gas	Rotary-Screw	175,100	88.2
Jaeger	A(doors	Standard	Gas	Rotary-	175,100	

Manufacturer	Model	Silenced or Standard	Type Eng.	Type Comp.	Test Avg. Cond. (cfm.psi)	Avg. Cond. Noise Lev. (cfm.psi) (dBA) at 7m*
	open)			Screw		
Jaeger	E	Standard	Gas	Vane	85,100	81.5
Jaeger	E(doors open)	Standard	Gas	Vane	85,100	
Worthington	60 G/2Qt	Silenced	Gas	Vane	160,100	74.2
Worthington	750-QTEX	Silenced	Diesel	Rotary-Screw	750,100	74.7

*Data taken from EPA Report - EPA 550/9-76-004.

9.4.3 FTA Noise and Vibration Assessment Procedure

Chapter 12 of the FTA Transit Noise and Vibration Guidance Handbook discusses construction noise evaluation methodology and contains the noise emission levels for construction equipment displayed in Table 9.9.

Table 9.9 FTA Construction Equipment Noise Emission Levels.

Equipment	Typical Noise Level (dBA) 50 ft from Source*
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Impact)	101
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rail Saw	90
Rock Drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike Driver	77
Tie Cutter	84

Equipment	Typical Noise Level (dBA) 50 ft from Source*
Tie Handler	80
Tie Inserter	85
Truck	88

*Table based on EPA Report, measured data from railroad construction equipment taken during Northeast Corridor improvement project and other measured data.

9.5 Links to Equipment Manufacturers

Table 9.10 contains web-based links to manufacturers of construction equipment. While few of these links contain noise-related data associated with the equipment, they provide descriptions and/or specifications related to the equipment, as well as sources for possibly obtaining additional information related to the equipment. Information in this table is by no means all-inclusive and does not represent any type of endorsement of the manufacturers, suppliers, or equipment. Users are hereby advised that the referenced websites may have certain restrictions, copyrights, etc., associated with any use of data contained therein.

Table 9.10 Equipment Manufacturers and Websites.

Equipment	Manufacturer	Website Address
Arrow Boards		
	North Star	http://northstar-traffic.com/index.cfm?SC=14&PT=1
	Trafcom	http://www.trafcon.com
	Allmand	http://www.allmand.com/MB%20AB%20page.htm
Articulated Trucks		
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=196
	Hitachi	http://www.hitachi-c-m.com/global/products/articulate/index.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=182b2104d7a1ce2c68b57b49f8c1436c&nav=prod#nb_0fb692066603522ee229a7ff28293d18
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/articulatedhaulers/
Asphalt Saws		
	Allied	http://www.alliedcp.com/products/rotocut.asp
Augers – See Drills / Augers		
Backhoes – See Loaders/Backhoes		
Boring Equipment – See Pile Drivers/Boring Equipment		
Compaction Equipment		
	Allied	http://www.alliedcp.com/products/compactor.asp
Compressors		

Equipment	Manufacturer	Website Address
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5714,00.html
	Compair	http://www.compair.com/Products/Portable_Compressors.aspx
Concrete and Asphalt Batch/Mixing Plants and Equipment		
	Con-E-Co	http://www.con-e-co.com/products.cfm
	Terex	http://www.terex.com/main.php?obj=prod&action=VIEW&id=a253f234f9c3bd69195320d1fe6e1cd9&nav=prod&cid=7713bf85ccb5a97458457e944ca4ed76
	Gunter &	http://www.guntert.com/concrete_mobilebatching.asp
	Rex Con	http://www.rexcon.com/products.html
Concrete Breakers/ Hydraulic Hammers/Hydraulic Breakers		
	Drillman	http://www.drillmanindia.com/concrete-breaker.html
	Hydro Khan	http:/www.sangi.co.kr/english/e_product1_2.php
	Stanley	http://www.stanley-hydraulic-tools.com/Hand%20Held/NoAmbreakers.htm
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/breakers.htm
Concrete Chain Saws		
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/concrete-saws.htm
Concrete Core Drilling Machines		
	Multiquip	http://www.multiquip.com/multiquip/318_ENU_HTML.htm
Concrete Cutters		
	Vermeer	http://www.vermeermfg.com/vcom/TrenchingEquipment/Line.jsp?PrdlnID=3618
Concrete/Material Pumps		
	Multiquip	http://www.multiquip.com/multiquip/309_ENU_HTML.htm
	Reed	http://www.reedpumps.com/
Concrete Mixer Trucks		
	Oshkosh	http://www.oshkoshtruck.com/concrete/products~overview~home.cfm
	London	http://www.lmi.ca/mixers.cfm
	Terex/Advance	http://www.advancemixer.com/trucks.asp
Concrete Saws		
	Multiquip	http://www.multiquip.com/multiquip/315_ENU_HTML.htm
	Diamond Core Cut	http://www.diamondproducts.com/dp_home.htm
Concrete Screeds		
	Multiquip	http://www.multiquip.com/multiquip/317_ENU_HTML.htm

Equipment	Manufacturer	Website Address
Concrete Vibrators		
	Multiquip	http://www.multiquip.com/multiquip/313_ENU_HTML.htm
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5722,00.html
Cranes		
	Malcolm Drilling	www.malcolmdrilling.com
	Link-Belt	http://www.linkbelt.com/lit/products/frameproducthome.htm
	Casagrande	http://www.casagrandegroup.com/home_fond.php
	Liebherr	http://www.liebherr.com/em/en/35381.asp
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=487c16c8ff145d0843f57512eafb8592&nav=prod
Crawler Tractors – See Dozers/Crawler Tractors		
Crushing and Screening Equipment		
	Cedarapids	http://www.cedarapids.com/crushscr.htm
	Hitachi	http://www.hitachi-c-m.com/global/products/crusher/index.html
	Komatsu	http://www.komatsu.com/ce/products/mobile_crushers.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=e75ed9c85681b27ffcfe5cadbd68c04e&nav=prod
Crushers/Pulverizers		
	Hydro Khan	http://www.sangi.co.kr/english/e_product3.php
Cutoff Saws		
	Multiquip	http://www.multiquip.com/multiquip/309_ENU_HTML.htm
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/cutoff%20saw.htm
Dozers/CrawlerTractors		
	John Deere	http://www.deere.com/en_US/cfd/construction/deere_const/crawlers/deere_dozer_selection.html
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=2
	Komatsu	http://www.komatsu.com/ce/products/crawler_dozers.html
Dewatering Pumps		
	Multiquip	http://www.multiquip.com/multiquip/371_ENU_HTML.htm
Drills / Augers		
	Malcolm Drilling	www.malcolmdrilling.com
	Casagrande	www.casagrandegroup.com/home_fond.php
	Soilmec	http://www.soilmec.com/_vti_g1_techno.aspx?rpstry=4_

Equipment	Manufacturer	Website Address
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=702f2c2ab1d75e021729f249258879f4&nav=prod#nb_cd8eeb0c300ecd6c7df8a7462718172d
Excavators		
	Hitachi	http://www.hitachi-c-m.com/global/products/excavator/index.html
	Caterpiller	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/compactexcavators/
		http://www.volvo.com/constructionequipment/na/en-us/products/wheeledexcavators/
		http://www.volvo.com/constructionequipment/na/en-us/products/crawlerexcavators/
	John Deere	http://www.deere.com/en_US/cfd/construction/deere_const/excavators/deere_excavator_selection.html
	Liebherr	http://www.liebherr.com/em/en/18891.asp
	Soilmec	http://www.soilmec.com/_vti_g1_t02.aspx?rpstry=29_
	Gehl	http://www.gehl.com/const/prod_sl.html
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=216
	Komatsu	http://www.komatsu.com/ce/products/crawler_excavators.html
		http://www.komatsu.com/ce/products/wheel_excavators.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=477c69a0ac11ed40efe034eb1420b8c6&nav=prod
	Link-Belt	http://www.lbxco.com/lx_series.asp
	Gradall	http://www.gradall.com/
	Badger Daylighting	http://www.badgerinc.com/
Fork Lifts – See Lifts / Variable Reach Fork Lifts/ Material Handlers		
Generators		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=6cde2dee72c250aafbd68c5b8c8d028b&nav=prod
	Multiquip	http://www.multiquip.com/multiquip/212_ENU_HTML.htm
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5714,00.html
	Baldor	http://www.baldor.com/products/generators/ts.asp
Graders		
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=190
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/MotorGraders/

Equipment	Manufacturer	Website Address
	Komatsu	http://www.komatsu.com/ce/products/motor_graders.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=b71fa964f478a2243ebbbbafa04bf814&nav=prod
Hand Compaction Equipment		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=4c93fdc86b1c7733c1564fc8c41ee691&nav=prod#nb_cbcf35494fa399b7350f8edf5bc27373
	Multiquip	http://www.multiquip.com/multiquip/56_ENU_HTML.htm
Hydraulic Hammers/Hydraulic Breakers – See Concrete Breakers/ Hydraulic Hammers/Hydraulic Breakers		
Jackhammers – See Rock Drilling Equipment/Jackhammers		
Lifts / Variable Reach Fork Lifts/ Material Handlers		
	Genie Lift	www.genielift.com
	Sky Track	www.kirby-smith.com/
	Ingersol-Rand	www.ingersollrand.com
	Terex Roadtec	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=6d18d9a15fdb6da73f44a893c21c0fb4&nav=prod http://www.roadtec.com/products/mtv/default.htm
Light Towers		
	Baldor	http://www.baldor.com/products/generators/mlt.asp
	Multiquip	http://www.multiquip.com/multiquip/293_ENU_HTML.htm
	Allmand	http://www.allmand.com/Night%20Lite%20Pro%20page.htm
Loaders/Backhoes		
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=54
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/backhoeloaders/
	John Deere	http://www.deere.com/en_US/cfd/construction/deere_const/backhoes/deere_backhoe_selection.html
	Komatsu	http://www.komatsu.com/ce/products/backhoe_loaders.html
Material Handlers – See Lifts / Variable Reach Fork Lifts/ Material Handlers		
Milling Machines		
	Wirtgen	https://www.wirtgenamerica.com/noflash.html
Mining Trucks – See Rigid Dump Trucks/Mining Trucks		
Pans – See Scrapers/Pans		
Pavers/Paving Equipment		

Equipment	Manufacturer	Website Address
	Caterpillar/ Barber Greene	http://www.cat.com/cda/layout?m=37840&x=7
	Rosco	http://www.leeboy.com/rosco/
	Bomag	http://www.bomag.com/americas/index.aspx?&Lang=478
	Gehl	http://www.gehl.com/const/prodpg_ap.html
	Leeboy	http://www.leeboy.com/leeboy/
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=7713bf85ccb5a97458457e944ca4ed76&nav=prod#nb_70af03a93dfc933f83a7e6afdc2dc833
	Ingersoll-Rand	http://www.road-development.irco.com/Default.aspx?MenuItemID=12
	Vogele	http://www.vogeleamerica.com/noflash.html
	GOMACO	http://www.gomaco.com/index.html
	Roadtec	http://www.roadtec.com/products/asphalt_pavers/default.htm
Pile Drivers/Boring Equipment		
	Soilmec	http://www.soilmec.com/_vti_g1_t09.aspx?rpstry=29_
	Leffer	http://www.leffer.com/hme.html
	Bauer	http://www.bauer.de/en/maschinenbau/produkte/drehbohrgeraete/bg_reihe/usbg15h.htm
Pipelayers/Trenchers		
	Liebherr	http://www.liebherr.com/em/en/18908.asp
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=28&archived=1
	Vermeer	http://www.vermeermfg.com/vcom/TrenchingEquipment/trenching-equipment.htm
	Ditchwitch	http://www.ditchwitch.com/dwcom/Product/ProductView/115
	Eagle	http://www.guntert.com/trenchers_home.asp
Profilers – See Roadway Planers/Profilers		
Rammers		
	Multiquip	http://www.multiquip.com/multiquip/56_ENU_HTML.htm
Rebar Benders/Cutters		
	Multiquip	http://www.multiquip.com/multiquip/1316_ENU_HTML.htm
Recyclers – See Stabilizers/Recyclers		
Rigid Dump Trucks/Mining Trucks		
	Hitachi	http://www.hitachi-c-m.com/global/products/rigid/index.html
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Liebherr	http://www.liebherr.com/em/en/18898.asp
	Komatsu	http://www.komatsu.com/ce/products/dump_trucks.html

Equipment	Manufacturer	Website Address
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=182b2104d7a1ce2c68b57b49f8c1436c&nav=prod#nb_d97e204d5e73962e595735d68fad8ae3
Roadway Planers/Profilers		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=7713bf85ccb5a97458457e944ca4ed76&nav=prod#nb_c9b8a083c7d9ebb936cd1e4f642eba59
	Roadtec	http://www.roadtec.com/products/cold_planers/default.htm
Rock Drilling Equipment/Jackhammers		
	Drillman	http://www.drillmanindia.com/rock-drilling-machine.html
	Whaker	http://www.wackergroup.com/webapp/wcs/stores/servlet/ViewAllModels?storeId=10051&prodgrpId=10070&langId=-1
	Sullair	http://www.sullair.com/corp/details/0,10294,CLI1_DIV61_ETI5721,00.html
	Allied	http://www.alliedcp.com/products/hammers.asp
Rollers – See Tampers/Rollers		
Scrapers/Pans		
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=e3959eefdc65adcc4e0e616b833694b1&nav=prod
Screening Equipment – See Crushing and Screening Equipment		
Slabbuster		
	Allied	http://www.alliedcp.com/products/slabbuster.asp
Slip Form Pavers		
	Huron	http://www.huronmanufacturing.com/
	Guntert & Zimmerman	http://www.guntert.com/concreteSlipformPavers.asp
Stabilizers/Recyclers		
	Bomag	http://www.bomag.com/americas/index.aspx?&Lang=478
	Komatsu	http://www.komatsu.com/ce/products/mobile_crushers.html
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=7713bf85ccb5a97458457e944ca4ed76&nav=prod#nb_d920dd8094cc1af5cb5d82359f8f227b
	Wirtgen	https://www.wirtgenamerica.com/noflash.html
	Roadtec	http://www.roadtec.com/products/cir/default.htm
Sweepers		
	Elgin	http://www.elginsweeper.com/index.asp
	Johnston	http://www.johnstonsweepers.com/
Tampers/ Rollers		

Equipment	Manufacturer	Website Address
	Bomag	http://www.bomag.com/americas/index.aspx?&Lang=478
	Komatsu	http://www.komatsu.com/ce/products/vibratory_rollers.html
	Whaker	http://www.wackergroup.com/webapp/wcs/stores/servlet/ViewAllModels?storeId=10051&prodgrpId=10070&langId=-1
	Lynx	http://www.stanley-hydraulic-tools.com/Lynx/tamper.htm
	Multiquip	http://www.multiquip.com/multiquip/181_ENU_HTML.htm
	Ingersoll-Rand	http://www.road-development.irco.com/Default.aspx?MenuItemID=15
Trenchers – See Pipelayers/Trenchers		
Trucks – See Articulated Trucks, Concrete Mixer Trucks, Rigid Dump Trucks/Mining Trucks		
Vacuum Units		
	Advanced Recycling Systems	www.arsrecycling.com/
	Vacmasters	http://www.vacmasters.com/airsystm.htm
	Vector	http://www.vector-vacuums.com/
Variable Message Signs		
	Allmand	http://www.allmand.com/MB%20only%20page.htm
	North Star	http://northstar-traffic.com/index.cfm?SC=13&PT=1
	Trafcom	http://www.trafcon.com
	Daktronics	http://www.daktronics.com/vms_prod/dak_vms_products.cfm
Vibratory Rammers		
	Whaker	http://www.wackergroup.com/webapp/wcs/stores/servlet/ViewAllModels?storeId=10051&prodgrpId=10070&langId=-1
Welders/Welding Equipment		
	Airgas	www.airgas.com
	Multiquip	http://www.multiquip.com/multiquip/408_ENU_HTML.htm
	Miller	http://www.millerwelds.com/products/
	Lincoln	http://www.mylincolnelectric.com/Catalog/equipmentseries.asp?browse=101|400|
Wheel Loaders		
	Hitachi	http://www.hitachi-c-m.com/global/products/loader/index.html
	Case	http://www.casece.com/products/products.asp?RL=NAE&id=30
	Caterpillar	http://www.cat.com/cda/layout?m=37840&x=7
	Volvo	http://www.volvo.com/constructionequipment/na/en-us/products/wheelloaders/
	Terex	http://www.terex.com/main.php?obj=category&action=BROWSE&cid=ad8a2ae2f52f113b6d143bfd7765b165&nav=prod

Equipment	Manufacturer	Website Address
	Komatsu	http://www.komatsu.com/ce/products/wheel_loaders.html
	TCM	http://www.tcmglobal.net/products/main02.html